Peripheral Collisions with STAR

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When heavy nuclei pass each other at large impact parameters, their electromagnetic fields can interact with each other in a two-photon interaction. These reactions produce a variety of final states, from lepton pairs to single mesons to meson and baryon pairs.

Meson coupling to two-photons depends on the meson quark content and isospin; mesons with anomalous coupling may be exotica such as glueballs (states consisting of several gluons), four-quark states ($q\overline{q}q\overline{q}$), hybrids ($q\overline{q}g$) or more radical possibilities. QCD bag model calculations indicate that these states are bound, and there are many experimental candidates[1].

The nuclei can also interact coherently via colorless hadronic interactions, often described as Pomeron exchange; the Pomeron represents the absorptive part of the nuclear potential. Pomerons are also treated as multiple gluon exchange. At RHIC, coherent Pomerons can be observed in the reaction $\gamma P \rightarrow V$ where V is a vector meson. Double-Pomeron interactions may also be seen. Because the Pomerons couple coherently to the entire nucleus, the reaction kinematics are similar to $\gamma\gamma$ interactions[2].

Because the photon flux is proportional to Z^2, with the Pomeron flux scaling as $A^{4/3}$, the rates for coherent collisions are very high[3]. Below a center of mass energy 1.5 GeV/c, the $\gamma\gamma$ luminosity will be higher than at existing or planned e^+e^- accelerators [3].

STAR can detect these processes by searching for events with 2 or 4 charged particles in the TPC, nothing else visible in the detector (including the forward TPCs), and with total $p_\perp$ less than $\sqrt{2}\hbar c/R$[4]. The major backgrounds are grazing hadronic nuclear collisions, beam gas events, and photonuclear interactions. Cosmic ray muons and upstream interactions can also appear at the trigger level. Table 1 shows the expected signals and backgrounds for two representative analysis channels. The two-track final state $f_2(1270) \rightarrow \pi^+\pi^-$ is a conventional $q\overline{q}$ meson, while the four-track final state $\gamma\gamma \rightarrow \rho^0\rho^0 \rightarrow \pi^+\pi^-\pi^+\pi^-$ is interesting because a bump observed near the $\rho^0\rho^0$ threshold by e^+e^- colliders "has not been explained by models in which only conventional resonances dominate"[1].

Channel	$f_2(1270)$	$\rho^0\rho^0$
Produced	1,900	42
Detected in STAR	660	12
Grazing AA bkgd.	1/5	0.2/0.8
Beam Gas bkgd.	1/1	0.1/0.1
Photonuclear bkgd.	24	1.2
Total Background	26/32	1.5/2.1

Table 1: Signals and backgrounds for gold beams, in 1,000's of events per year. The numbers before and after the slash are for FRITIOF and VENUS simulations respectively.

References

[1] R. M. Barnett *et al.* (PDG Group), Phys. Rev. **D54**, 1 (1996), pg. 568.

[2] S. Klein and E. Scannapieco, "The Gold Flashlight: Coherent Photons (and Pomerons) at RHIC", LBL-40457, presented at *Photon '97*, May 10-15, 1997, to be published in the Proceedings.

[3] S. Klein and E. Scannapieco, STAR Note 243, Feb., 1995 (unpublished).

[4] J. Nystrand and S. Klein, "Two-Photon Physics at RHIC: Separating Signals from Backgrounds", LBL-41111, presented at *Hadron '97*, August 25-30, 1997, to be published in the Proceedings.